Treatment of Infected Facial Implants

Kriti Mohan, MD[1] Joshua A. Cox, MD[1] Ryan M. Dickey[1] Paula Gravina, MD[1] Anthony Echo, MD[2] Shayan A. Izaddoost, MD, PhD[1] Anh H. Nguyen, MD[1]

[1] Division of Plastic and Reconstructive Surgery, Baylor College of Medicine, Houston, Texas
[2] The Institute for Reconstructive Surgery, Houston Texas

Address for correspondence Shayan A. Izaddoost, MD, PhD, Department of Surgery, Baylor College of Medicine, 1977 Butler Blvd., Suite E6.100, Houston, TX 77030 (e-mail: shayani@bcm.edu).

Semin Plast Surg 2016;30:78–82.

Abstract

Alloplastic facial implants have a wide range of uses to achieve the appropriate facial contour. A variety of materials such as metals, polymers, ceramics and synthetic injectable fillers are available to the reconstructive and aesthetic surgeon. Besides choosing the right surgical technique and the adequate material, the surgeon must be prepared to treat complications. Infection is an uncommon but serious complication that can cause displeasing consequences for the patient. There are few references in literature regarding treatment and management of facial implant–related infections. This study aims to discuss the role of biofilm in predisposing alloplastic materials to infection, to provide a review of literature, to describe our own institutional experience, and to define a patient care pathway for facial implant–associated infection.

Keywords
- alloplast
- facial implant infection
- biofilm
- Medpor

Augmentation of the craniofacial skeleton to achieve aesthetic balance has long been a desired goal. Alloplastic facial implantation technology has evolved tremendously since its introduction in the early 20th century, with the first facial augmentations of the chin using ivory and gold.[1] Through the 1970s, the treatment of facial fractures was limited to interosseous and suspension wiring.[2] Currently, a variety of materials are at the disposal of the facial surgeon, including metals, polymers, ceramics, adipose tissue, and biologic or synthetic injectable fillers.[3–18] Facial implants may be used in a variety of reconstructive and aesthetic settings, and may be implanted in many anatomical positions.[6,7,9–12,14,15] Common locations are the chin, midface, and nose, with multiple options depending on patient esthetic goals.

Despite their widespread use and established clinical utility in facial surgery, complications have been well-documented including pain, aesthetic dissatisfaction, visibility, extrusion, and infection.[5,9,13,19] Infection is an uncommon, though serious complication often necessitating reoperation and implant exchange. There is a general lack of consensus in the literature regarding the management of infectious complications. We aim to review the literature, describe our own institutional experience, and define a patient care pathway for implant-associated infections.

Implant Materials and Infections

Although the use of autologous tissue for reconstruction has historically been the standard of care for facial reconstruction, there has also been an increased use of a variety of alloplastic materials ranging from metals such as titanium to polymers including porous polyethylene, polytetrafluoroethylene, silicone, and methyl methacrylate among others. These alloplastic materials can improve operative efficiency as well as reduce donor site morbidity, thereby providing an attractive alternative for both surgeons and patients. Although the alloplastic material of choice often depends on the location and goals of reconstruction, polyetherketone (PEEK) implants have been considered the gold standard with porous polyethylene (MEDPOR, Stryker) as a promising alternative.[6] These implants are useful in a variety of locations including the orbit, zygoma, and mandible with infection rates as low as 5.7 to 12.5%. Porous implants are designed to allow fibrovascular ingrowth and vascularization with the goal of preventing infection. On the other hand, it has been shown that any bacterial infiltration of a porous implant prior to implantation will inevitably lead to infection.[15]

Of all the risks and complications specific to the use of these alloplastic materials, infection poses one of the most challenging to treat, and can necessitate complete removal of

Issue Theme Medical Device Infections; Guest Editor, Shayan A. Izaddoost, MD, PhD

DOI http://dx.doi.org/10.1055/s-0036-1580727.
ISSN 1535-2188.

the implant and loss of reconstruction. As there is no consensus on an algorithm by which to manage these infections, it is important to understand the factors that predispose alloplastic materials to infection to appropriately prevent and treat them. One of the most important concepts in understanding alloplastic infections is the role of the biofilm. A biofilm is defined as an aggregate community of microorganisms encapsulated within a self-developed polymeric matrix and irreversibly adherent to a living or inert surface.[20,21] Although the first observations of biofilms were made centuries ago in relation to dental plaque, visualization was not possible until the invention of scanning electron microscopy.[22,23] In understanding the structure and function of biofilms, it is crucial to recognize that they are a heterogeneous structure of bacterial colonies, which respond to stimuli, grow, and can interfere with macrophage phagocytosis. They do not generate an immune response and can have up to a 1,000-fold improved resistance to antibiotics.[24] Although attempts have been made to impregnate stocked implants with antibiotics in an effort to reduce biofilm formation, the long-term efficacy of soaked implants is poor.[25] The greatest risk for infection of facial implants is from inoculation of bacteria at the time of the initial surgery, and the subsequent formation of biofilm. Malaisrie et al used guinea pig models to demonstrate anatomical evidence of the development of biofilms at 1 week after being contaminated with *Staphylococcus aureus* in a variety of facial bioimplants: titanium, silicone, ion-bombarded silicone, expanded polytetrafluoroethylene (e-PTFE; GORE-TEX), and porous high-density polyethylene (PHDPE; Porex Surgical Inc.). The physiology of biofilms also explains why facial implant infections may frequently present as subacute or chronic infections, often leading to indolent clinical infections.[26] As antibiotics may be incapable of penetrating such biofilms, removal of the implant may be the only remaining treatment.[1]

Treatment and Management

For decades the treatment of implant-related infections from any source has been empiric, and then culture-directed antibiotic therapy, incision and drainage, and implant removal. However, the morbidity and mortality associated with hardware and/or device removal in cardiothoracic, vascular, and orthopedic surgery has led to the development of more conservative treatment alternatives. In these specialties, more recent strategies for the treatment of implant-related infections consist of wound debridement and systemic antibiotic use with the local delivery of higher concentrations of antibiotics in an attempt to salvage the infected device. In orthopedic surgery, the treatment of implant-related infections in septic revision arthroplasty has evolved toward two-stage revision protocols using antibiotic-loaded cement spacers. In trauma surgery, gentamicin polymethacrylate beads and gentamicin-loaded collagen sheets are often used with clinical success, although controlled and randomized trials have not yet been performed.[27] Gentamicin collagen sponges have also been reported as an adjunct in the salvage of infected cochlear and breast implants.[28] Given the success of these implant salvage approaches in other specialties, plastic surgeons are also beginning to attempt salvage of infected or exposed facial implants. Although there has yet to be a head-to-head controlled study examining efficacy, many studies have demonstrated a variety of approaches with variable success.

A series of 285 MEDPOR grafts used for craniofacial reconstruction stratified a graft "survival" curve based on diagnosis at time of admission and site of implant placement. Both factors were considered predictors of graft outcomes with certain sites (i.e., nose, maxilla, and ear) and diagnosis at admission (i.e., syndromic patients with previous surgeries) being associated with a higher risk of implant failure.[29] Fialkov et al suggested that the use of porous polyethylene implantation through a transoral route was correlated with a significant risk of postoperative infection.[30] Menderes et al found that placement of porous polyethylene implants directly under the skin without coverage of periosteum or another fascial envelope has an increased risk of early as well as late exposure.[31]

In considering the importance of biofilms in these infections, Desai et al showed anatomical evidence of microbial biofilm on the explanted implant of a patient presenting infection 1 year after a GORE-TEX dorsal nasal implant. Conservative management with a 3-week course of a quinolone antibiotic was initially attempted, leading to a mild resolution of symptoms; however, the symptoms returned after discontinuing the antibiotics. Cultures of the implant isolated *S. aureus* sensitive to the quinolone used for treatment, demonstrating the medical importance of biofilm as a highly resistant barrier to host defenses and antibiotics.[19]

Another consideration in facial implant infections is the type of bacteria that may be responsible for the infection. While skin flora including staphylococcus and streptococcus are the most common culprits, atypical bacteria may also be involved and require quite different antimicrobial coverage to eradicate the infection. For example, mycobacteria are emerging as an important category that causes local cutaneous infections even in immunocompetent patients. Rhie et al described a case of nontuberculous mycobacterial infection related to a nasal silicone implant. These organisms can have a late presentation and show negative results in routine cultures. Further sophisticated tests such as polymerase chain reaction can detect the organisms more precisely; treatment consists of incision and drainage, implant removal, and 3 months of clarithromycin.[32]

Although antibiotic therapy is often attempted at initial presentation of these infections, exposure of an implant often necessitates surgical management. Lu et al reported the use of subconjunctival tissue flaps to repair exposed hydroxyapatite (HA) orbital implants in 126 patients with $>$ 3-mm exposure with a clean white anterior implant surface. Removal of the orbital prosthesis was followed by topical tobramycin eye ointment twice daily to the exposed HA for the week prior to surgery. An antibiotic solution with gentamicin was used for intraoperative irrigation along with strong suction to facilitate washout of all necrotic debris in the depth of the sphere. The complication rate was 17.5%, with only one of the patients experiencing implant infection.[33] However, the average

follow-up of 24 months is relatively short given the subacute or chronic presentation of many implant infections and extrusions that can appear as late as 47 years after insertion.[34]

Although there is not yet enough data to guide the surgeon's endeavor of implant salvage, future strategies may include a focus on nonantibiotic therapy directed toward physical biofilm disruption. Therapies such as laser-produced pressure waves, pulsed ultrasound, hydrodynamic flushing, and probiotics and surfactants have shown laboratory and clinical promise as potential treatments of biofilms. For example, low-frequency, high-intensity ultrasound has been shown to improve antibiotic efficacy when treating patients with refractory chronic rhinosinusitis as biofilms are typical of chronic rhinosinusitis. This may be due to a variety of possible mechanisms including increasing antibiotic transport to bacteria, the permeability of cell membranes, and the metabolic activity of biofilm bacteria to increase susceptibility to antibiotics affecting active organisms.[35,36]

There are numerous considerations in treating facial implant infections including type and location of the implant, which is partly responsible for the lack of consensus in how best to manage these infections. Given the current literature indicating the limited success of implant salvage, it becomes evident that the best strategy against facial implant infection is to prevent its occurrence. Of paramount importance is a good physical examination and evaluation of the skin, subcutaneous tissue, and surrounding structures that constitute the soft tissue envelope. Other preventative measures include implementation of clinical practice routines such as preoperative clinical and radiograph screening to diagnose and treat any dental pathology or facial sinus pathology close to surgical areas, maintaining adequate sterility, minimizing glove powder and debris on the implant, use of intraoperative antibiotic irrigation, and adequate site selection to provide optimal fixation and coverage of the implant.[37] If transoral or transnasal implantation is performed, it is crucial to carefully clean the mucosal areas with chlorhexidine-gluconate, povidone-iodine, or cetrimide solution.[38] Other important factors to consider are the choice of foreign material used, the degree of integration with the surrounding host tissues, and the expectations of long-term support and biocompatibility.[6]

Case Report 1

A 52-year-old man was diagnosed with a right maxillary sinus mass with local destruction and orbital invasion. He underwent a right suprastructure maxillectomy via a Weber-Ferguson incision to remove the mass. Due to concerns for an aggressive tumor, the head and neck surgery service opted to not reconstruct the resultant defect at the time of resection. He was lost to follow-up for several months, but presented to the plastic surgery clinic 8 months later.

Given that he did not require neoadjuvant radiotherapy, the patient underwent alloplastic reconstruction with a prefabricated three-dimensional model MEDPOR two-third orbital porous polypropylene implant. During surgery, the previous Weber-Ferguson incision was used to access the defect and to place the device. The implant was fixated with Stryker gold midface plates and 1.2-mm screws (Stryker Leibinger Midface module). The skin flap was anchored to the infraorbital rim portion of the implant with polydioxanone sutures (Ethicon) in a simple interrupted fashion. The remaining facial incision was closed in layers. An immediate postoperative computed tomography (CT) scan showed adequate anatomical reconstruction of the zygomaticomaxillary defect. His immediate postoperative course was uncomplicated. He completed a standard course of postoperative oral antibiotics and was seen for routine follow up twice before being lost to follow-up.

Two years later, the patient presented with facial cellulitis and minimal drainage from his right nostril that were treated with intravenous (IV) antibiotics for 4 days and then completed a 3-week course of oral antibiotics. Given the clinical improvement, the patient declined further intervention including antibiotics or implant removal. He subsequently presented 2 months later with facial cellulitis, was treated with removal of the ipsilateral third molar, and declined removal of the facial implant.

The patient presented again with a cutaneous fistula and right cheek cellulitis, 3 years later (►**Fig. 1**). He was treated with debridement of the infraorbital hardware with attempted salvage of the MEDPOR implant based on intraoperative evaluation. However, he again developed localized cellulitis with a draining abscess. He was admitted for IV antibiotics and removal of the implant. He was subsequently reconstructed with a free osteocutaneous fibula flap (►**Fig. 2**).

Case Report 2

A 30-year-old man underwent delayed reconstruction with a MEDPOR implant and temporoparietal fascia flap following a degloving injury. He had a normal postoperative course, but presented 4 months later with repeated episodes of subacute cellulitis that resolved with antibiotics. Ultimately, however, he

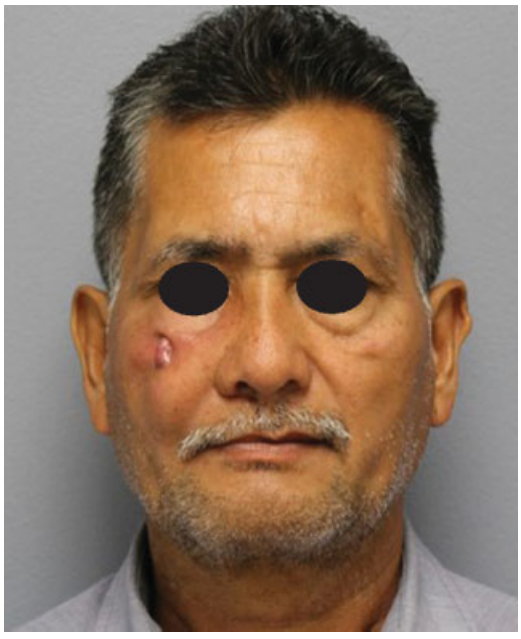

Fig. 1 Development of sinus tract prior to implant removal.

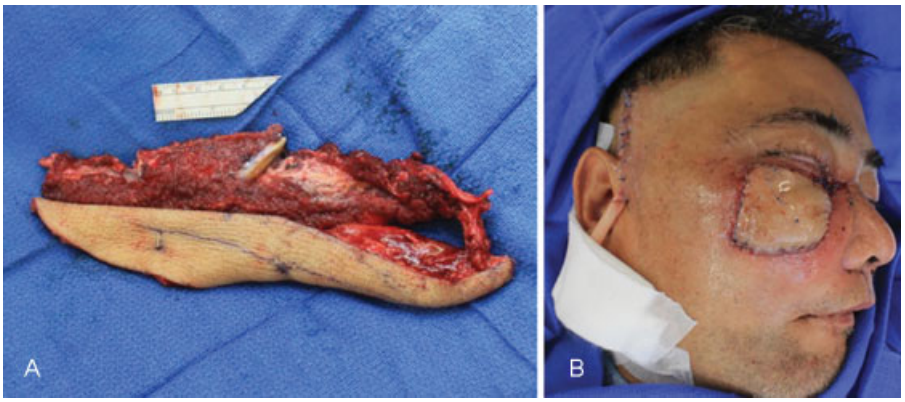

Fig. 2 (A) Free fibula osteocutaneous flap prior to tailoring for defect. (B) Inset of free fibula osteocutaneous flap.

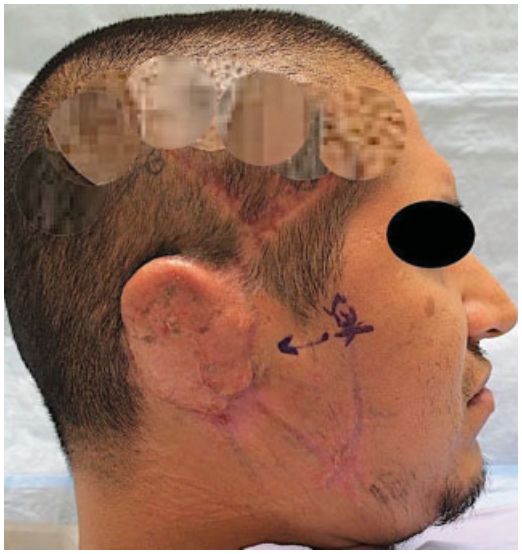

Fig. 3 Periprosthetic cellulitis.

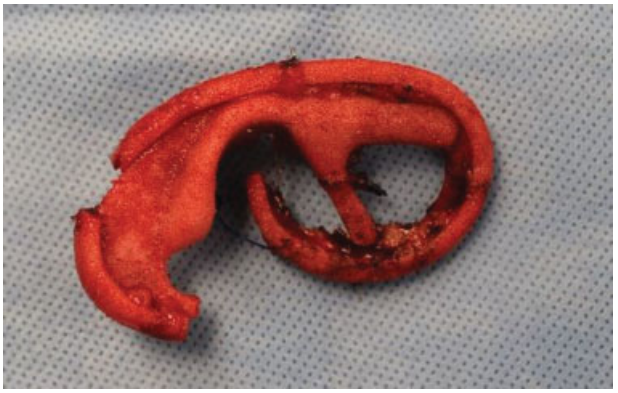

Fig. 4 MEDPOR implant after removal.

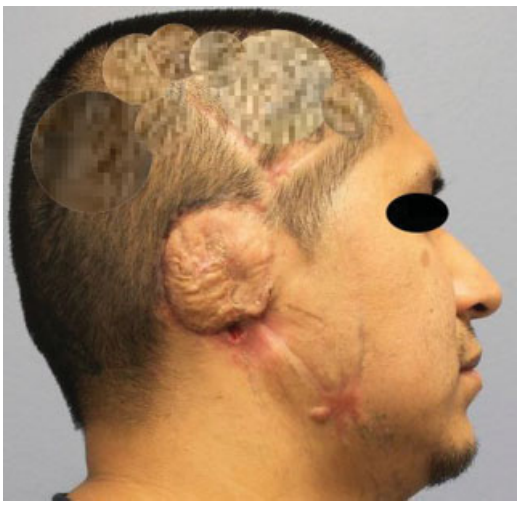

Fig. 5 One-month postimplant removal.

presented with severe swelling, redness, malaise, aches, and purulent drainage from the implant (►**Fig. 3**). He was treated with IV antibiotics and removal of the implant (►**Fig. 4**). The patient did well postoperatively and was discharged pending reconstruction with autologous rib cartilage (►**Fig. 5**).

Conclusions

In our experience, as demonstrated by both case reports, we initially attempted implant salvage through antibiotic treatment as well as operative debridement. In both cases, however, the porous implants appeared to be already seeded with biofilms that prevented true vascular ingrowth as well as antibiotic penetration. This was demonstrated by the chronic and persistent nature of these infections despite multiple courses of antibiotics. Despite efforts to debride these biofilms operatively, infection recurred and ultimately necessitated removal of the implants. In both cases, autologous reconstruction remained the safe alternative for ultimate reconstruction for these patients. Given the paucity of literature demonstrating success with implant salvage, a reasonable algorithm for management of these infections seems to be a trial of antibiotics with operative debridement, with the consideration that implant removal is crucial should the infection persist or recur.

References

1 Carlin GA. Personally fabricated chin implants. Plast Reconstr Surg 1973;51(2):121–128
2 Adams WM, Adams LH. Internal wire fixation of facial fractures; a fifteen-year follow-up report. Am J Surg 1956;92(1):12–17
3 Yano T, Okazaki M, Tanaka K, Iida H. The flap sandwich technique for a safe and aesthetic skull base reconstruction. Ann Plast Surg 2016;76(2):193–197
4 Miles BA, Sinn DP, Gion GG. Experience with cranial implant-based prosthetic reconstruction. J Craniofac Surg 2006;17(5):889–897
5 Campbell CA, Lin KY. Complications of rigid internal fixation. Craniomaxillofac Trauma Reconstr 2009;2(1):41–47
6 Niechajev I. Facial reconstruction using porous high-density polyethylene (medpor): long-term results. Aesthetic Plast Surg 2012; 36(4):917–927
7 Romo T III, Morris LG, Reitzen SD, Ghossaini SN, Wazen JJ, Kohan D. Reconstruction of congenital microtia-atresia: outcomes with the Medpor/bone-anchored hearing aid-approach. Ann Plast Surg 2009;62(4):384–389
8 Gosau M, Draenert FG, Ihrler S. Facial augmentation with porous polyethylene (Medpor)—histological evidence of intense foreign body reaction. J Biomed Mater Res B Appl Biomater 2008;87(1): 83–87
9 Ramakrishnan JB, Danner CJ, Yee SW. The use of porous polyethylene implants to correct nasal valve collapse. Otolaryngol Head Neck Surg 2007;136(3):357–361
10 Godin M, Costa L, Romo T, Truswell W, Wang T, Williams E. Gore-Tex chin implants: a review of 324 cases. Arch Facial Plast Surg 2003;5(3):224–227
11 Godin MS, Waldman SR, Johnson CM Jr. Nasal augmentation using Gore-Tex. A 10-year experience. Arch Facial Plast Surg 1999;1(2): 118–121, discussion 122
12 Conrad K, Torgerson CS, Gillman GS. Applications of Gore-Tex implants in rhinoplasty reexamined after 17 years. Arch Facial Plast Surg 2008;10(4):224–231
13 Bain CJ, Odili J. Late infection of an alloplastic chin implant masquerading as squamous cell carcinoma. J Plast Reconstr Aesthet Surg 2012;65(6):e151–e152
14 Hopping SB, Joshi AS, Tanna N, Janjanin S. Volumetric facelift: evaluation of rhytidectomy with alloplastic augmentation. Ann Otol Rhinol Laryngol 2010;119(3):174–180
15 Yaremchuk MJ. Secondary malar implant surgery. Plast Reconstr Surg 2008;121(2):620–628
16 Marchac D, Greensmith A. Long-term experience with methylmethacrylate cranioplasty in craniofacial surgery. J Plast Reconstr Aesthet Surg 2008;61(7):744–752, discussion 753
17 Lee DW, Kim JY, Lew DH. Use of rapidly hardening hydroxyapatite cement for facial contouring surgery. J Craniofac Surg 2010;21(4): 1084–1088
18 Attenello NH, Maas CS. Injectable fillers: review of material and properties. Facial Plast Surg 2015;31(1):29–34
19 Desai SC, Moradzadeh A, Branham G. Anatomical evidence of microbial biofilms in an alloplastic nasal implant. Aesthetic Plast Surg 2013;37(2):468–471
20 Cassuto D, Sundaram H. A problem-oriented approach to nodular complications from hyaluronic acid and calcium hydroxylapatite fillers: classification and recommendations for treatment. Plast Reconstr Surg 2013;132(4, Suppl 2):48S–58S
21 Rohrich RJ, Monheit G, Nguyen AT, Brown SA, Fagien S. Soft-tissue filler complications: the important role of biofilms. Plast Reconstr Surg 2010;125(4):1250–1256
22 Leewenhoeck A. An Abstract of a Letter from Mr. Anthony Leewenhoeck at Delft, Dated Sep. 17, 1683. Containing some microscopical observations, about animals in the scurf of the teeth, the substance call'd worms in the nose, the cuticula consisting of scales. Philosophical Transactions 1684;14(155–166):568–574
23 Costerton JW, Geesey GG, Cheng KJ. How bacteria stick. Sci Am 1978;238(1):86–95
24 Ceri H, Olson ME, Stremick C, Read RR, Morck D, Buret A. The Calgary biofilm device: new technology for rapid determination of antibiotic susceptibilities of bacterial biofilms. J Clin Microbiol 1999;37(6):1771–1776
25 Keefe MS, Keefe MA. An evaluation of the effectiveness of different techniques for intraoperative infiltration of antibiotics into alloplastic implants for use in facial reconstruction. Arch Facial Plast Surg 2009;11(4):246–251
26 Malaisrie SC, Malekzadeh S, Biedlingmaier JF. In vivo analysis of bacterial biofilm formation on facial plastic bioimplants. Laryngoscope 1998;108(11 Pt 1):1733–1738
27 Diefenbeck M, Mückley T, Hofmann GO. Prophylaxis and treatment of implant-related infections by local application of antibiotics. Injury 2006;37(Suppl 2):S95–S104
28 Lapid O. Use of gentamicin collagen sponges for the treatment of periprosthetic breast implant infection. J Plast Reconstr Aesthet Surg 2011;64(12):e313–e316
29 Cenzi R, Farina A, Zuccarino L, Carinci F. Clinical outcome of 285 Medpor grafts used for craniofacial reconstruction. J Craniofac Surg 2005;16(4):526–530
30 Fialkov JA, Holy C, Forrest CR, Phillips JH, Antonyshyn OM. Postoperative infections in craniofacial reconstructive procedures. J Craniofac Surg 2001;12(4):362–368
31 Menderes A, Baytekin C, Topcu A, Yilmaz M, Barutcu A. Craniofacial reconstruction with high-density porous polyethylene implants. J Craniofac Surg 2004;15(5):719–724
32 Rhie JW, Jeong YJ, Kim SW. Nontuberculous mycobacterial infection related to nasal implant. J Craniofac Surg 2013;24(4): 1257–1259
33 Lu L, Shi W, Luo M, Sun Y, Fan X. Repair of exposed hydroxyapatite orbital implants by subconjunctival tissue flaps. J Craniofac Surg 2011;22(4):1452–1456
34 Rubin JP, Yaremchuk MJ. Complications and toxicities of implantable biomaterials used in facial reconstructive and aesthetic surgery: a comprehensive review of the literature. Plast Reconstr Surg 1997;100(5):1336–1353
35 Smith A, Buchinsky FJ, Post JC. Eradicating chronic ear, nose, and throat infections: a systematically conducted literature review of advances in biofilm treatment. Otolaryngol Head Neck Surg 2011; 144(3):338–347
36 Bartley J, Young D. Ultrasound as a treatment for chronic rhinosinusitis. Med Hypotheses 2009;73(1):15–17
37 Hasson O, Levi G, Conley R. Late infections associated with alloplastic facial implants. J Oral Maxillofac Surg 2007;65(2): 321–323
38 Kosutic D, Uglesic V, Perkovic D, et al. Preoperative antiseptics in clean/contaminated maxillofacial and oral surgery: prospective randomized study. Int J Oral Maxillofac Surg 2009;38(2):160–165